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Research paper

Adoption prospects and implication problems of practicing conservation agriculture in Bangladesh: A socioeconomic diagnosis

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ABSTRACT

The research was conducted to evaluate the problems and prospects of adopting conservation agriculture in Jamalpur and Bogra districts of Bangladesh. A total of 120 farmers (20 from focal and 100 from control group) were surveyed for collecting necessary data and information. A combination of descriptive statistics and mathematical techniques was used to analyze the data. Focal farmers followed the basic principles of conservation agriculture but control farmers continued conventional crop farming practices. Focal farmers were more profitable compared to control farmers in terms of wheat and bean production. Less production due to minimum tillage, difficulties in maintenance, lack of extension service etc. was the major problems faced by the farmers. Knowledge on soil conservation and soil quality improvement, use of organic fertilizer, etc. was found as strengths; management of crop residue, scarcity of cowdung, etc. were found as weaknesses; labour opportunities, market demand, etc. were found as opportunities; and climate change and price fluctuation were found as threats of adopting conservation agriculture. Regular extension contact, arrangement of training programmes and input support are to be ensured by different government and non-government organizations to motivate farmers for adopting conservation agriculture practice.

1. Introduction

Bangladesh is a role model for the United Nations to be showcased for its excellent development performance to developing nations in the field of agriculture. Soil fertility and crop productivity are reducing over the time in Bangladesh due to monoculture of cereal crops (mainly rice) (Kafiluddin and Islam, 2008). Introduction of conservation agriculture plays a vital role in increasing organic matter content in soil and in reducing soil erosion. It is a modern agricultural practice which is gaining popularity in many parts of the world. It aims to make better use of agricultural resources through the integrated management of available soil, water and biological resources, combined with limited external inputs. It offers an opportunity for arresting and reversing downward spiral of resource degradation, decreasing cultivation costs and making agriculture more resource-use-efficient, competitive and sustainable by maintaining a permanent or semi-permanent organic soil cover, crop rotation and minimum soil disturbance (FAO, 2007). Crop production profitability under this farming practice tends to increase over time relative to conventional agriculture. In economic terms, conservation agriculture performs better than tillage-based farming. Three or four years crop rotations can reduce the use of nitrogen fertilizer and pesticide. The labour inputs in this farming practice could be reduced by 75% (IFAD, 2005).

Modalities of such farming have been described in a good number of literatures in the global context (USDA, 1980; Lampkin, 1990; IFOAM, 1996; FAO, 2007) as well as in the context of Bangladesh (Rahman, 2001; Sarker and Itohara, 2008). Although conservation agriculture aims to help farmers to earn more income with reduced amount of labour, irrigation and other high energy external input costs; keep land healthy and productive; and conserve natural environment (Lampkin and Padel, 1994); about 8–10% farmers around the world follow this practice (Parrott et al., 2006; Willer et al., 2008). There is also policy debate on whether conservation agriculture can ensure better sustainability and livelihood enhancement of the resource poor farmers. In light of this situation, this research aimed to identify the problems and possible opportunities of conservation agriculture practice, and suggest policy recommendations.

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2. Materials and methods

2.1. Study areas and sample selection

The study was conducted in two districts of Bangladesh which were: Sadar upazila of Jamalpur district [conservation agriculture practice by wheat farmers under the observation of International Maize and Wheat Improvement Center (CIMMYT); major crop: wheat] and Shajahanpur upazila of Bogra district [conservation agriculture movement under Comprehensive Village Development Cooperative Limited (CVDCL) and Village Development Association (VDA); major crop: bean]. Two categories of farmers were targeted for investigation namely, focal farmers (farmers practicing conservation agriculture, receiving technical and logistic support from the researchers and having regular contact with extension agents) and control farmers (farmers practicing traditional agriculture and receiving no training and technical support from the researchers/extension agents). In each locale of the study, a total of 60 farmers (10 focal and 50 control) were selected; of which focal farmers were selected purposively and control farmers were selected randomly. Thus, a total of 120 farmers were included as the sample for observation and data collection (socioeconomic characteristics of focal and control farmers has been represented in Tables 1 and 2, respectively). Primary data were collected through questionnaire survey, focus group discussion (FGD) and key informant interview (KII) with local stakeholders. Secondary sources of data in the form of handouts, reports, publications, notifications, etc. having relevance with this study were also consulted.

The focal farmers were selected by the consultation with the members of the concerned community based organizations. The farmers were agreed to adopt a number of conservation agriculture practices as suggested by the researchers through FGD. The researchers provided with a limited amount of input support to the focal farmers without any cost for practicing conservation agriculture. Necessary technical advices were provided and the implementation of the conservation agriculture practices in the farmers' fields time to time was monitored by the research team and local extension agents.

In orthodoxy with the research objectives, a structured questionnaire was developed for collecting relevant primary data from the both categories of farmers. At first, the draft questionnaire was prepared and pre-tested on handful respondents for its validity and reliability. In the pre-test, concentration was given to identify and categorise information which was not included in the draft questionnaire. Then some parts of questionnaire were improved, rearranged and modified in light of the field experiences. Lastly, the final questionnaire was prepared to importune information. The questions were properly structured so that even the most reluctant informant could have no hesitation in passing on the necessary information. Sometimes, the farmers could not remember some information in accurate manner which was exactly needed to the researchers. In case of that situation, the researchers noted the information in the questionnaire based on the ideas of the respondents. For some cases, the researchers faced startling intrusion from over interested side talkers while collecting data from the respondents. However, the researchers tried to overcome this problem as far as possible with ample dexterity and proficiency.

2.2. Analytical techniques

A combination of descriptive statistics (i.e., averages, percentages, minimum, maximum, etc.) and mathematical techniques (problem confrontation index) was used to achieve the objective of the study. Problems of adopting conservation agriculture practice were analyzed with problem confrontation index (PCI) (Uddin et al., 2017). An overall score of the problems faced by the focal and control farmers was computed for each farmer by adding their scores of the problems in all 13 selected problems. Each farmer was asked to indicate the extent of difficulty caused by each of the problems by checking any of the four responses such as 'frequently, 'occasionally, 'rarely and 'not at all', and weights were assigned to these responses as 3, 2, 1 and 0, respectively. Thus, the possible range of the problem confrontation score for each problem could be 0 to 3 and possible range of overall problem confrontation score for 13 constraints could range from 0 to 39. In this case, 0 indicated there was no problem and 39 indicated that the problem was very frequent. A problem confrontation index (PCI) for each 13 selected problems was computed by using the following formula:

$$PCI = (P_{frequently} \times 3) + (P_{occasionally} \times 2) + (P_{rarely} \times 1) + (P_{not\ at\ all} \times 0)$$

Where, $P_{frequently}$ = Number of responses indicating the problem occurred frequently; $P_{occasionally}$ = Number of responses indicating the problem occurred occasionally; P_{rarely} = Number of responses indicating the problem occurred rarely; and $P_{notatall}$ = Number of responses indicating no problem at all.

Problem confrontation index (PCI) for any of the selected problem could range from 0 to 60 for focal farmers and 0 to 300 for control farmers where 0 indicated that the problem was not faced at all by the farmers; and 60 and 300 indicated that the problem was frequently faced by focal and control farmers, respectively.

SWOT analysis was done to identify the problems and potentials of conservation agriculture practice. A SWOT analysis guides to identify the positives and negatives inside of the organization (S-W) and outside of it in the external environment (O-T). Finally, suggestions and recommendations were provided with by the author in the form of recommendation matrix for expanding conservation agriculture that will be synchronized for policy options.

Table 1
Socioeconomic characteristics of focal farmers.
Source: Field survey, 2015–16.

Particulars		No.	%	Avg.	Std. deviation	Kurtosis	Skewness	Range	Min.	Max.
Sex	Male	13	65	–	–	–	–	–	–	–
	Female	7	35	–	–	–	–	–	–	–
Age	15–29 years	6	30	20	5	−2	0	12	15	28
	30–49 years	11	55	40	6	−2	0	16	31	48
	Above 50 years	3	15	57	6	–	2	11	53	65
Land holding (ha)	Homestead area	–	–	0.09	0.01	−0.91	−0.13	0.05	0.06	0.11
	Owned cultivable land	–	–	0.19	0.03	−0.84	0.14	0.09	0.15	0.24
	Rented/mortgaged/leased-in	–	–	0.23	0.02	−1.57	−0.07	0.06	0.20	0.26
	Rented/mortgaged/leased-out	–	–	0.04	0.01	−1.49	0.29	0.03	0.03	0.06
	Area under pond	–	–	0.03	0.01	−0.73	0.46	0.03	0.01	0.05
	Fallow land	–	–	0.02	0.01	−1.20	−0.01	0.04	0.00	0.04
Farming types	Subsistence	4	20	–	–	–	–	–	–	–
	Commercial	16	80	–	–	–	–	–	–	–

Table 2
Socioeconomic characteristics of control farmers.
Source: Field survey, 2015–16.

Particulars		No.	%	Avg.	Std. deviation	Kurtosis	Skewness	Range	Min.	Max.
Sex	Male	78	78	–	–	–	–	–	–	–
	Female	22	22	–	–	–	–	–	–	–
Age	15–29 years	27	27	22	4	−1	0	13	16	28
	30–49 years	58	58	41	5	−1	0	18	31	48
	Above 50 years	15	15	61	6	0	0	19	51	70
Land holding (ha)	Homestead area	–	–	0.07	0.01	−1.17	−0.01	0.02	0.06	0.08
	Owned cultivable land	–	–	0.14	0.01	−1.23	−0.07	0.04	0.12	0.16
	Rented/mortgaged/leased-in	–	–	0.19	0.02	−1.20	0.07	0.06	0.16	0.22
	Rented/mortgaged/leased-out	–	–	0.06	0.02	−1.21	−0.10	0.06	0.03	0.09
	Area under pond	–	–	0.04	0.02	−1.22	−0.07	0.06	0.01	0.07
	Fallow land	–	–	0.03	0.01	−1.14	0.09	0.02	0.02	0.04
Farming types	Subsistence	24	24	–	–	–	–	–	–	–
	Commercial	76	76	–	–	–	–	–	–	–

3. Results

3.1. Adopter categories

In case of adopting an innovation like conservation agriculture practice, the percentages of innovators were 5.0%, early adopters were 15.0%, early majority were 30.0%, late majority were 35.0% and laggards were 15.0%.

3.2. Estimation of profitability per unit for command area

The cost of producing one quintal wheat and return from one quintal wheat is shown in Table 3. It is experienced that total output of wheat was decreased by 0.01 quintal in case of focal farmers after adopting conservation agriculture, but in case of control farmers, it was increased by 0.02 quintal. The reasons behind the decrease in crop production of focal farmers were reduced tillage and no use of synthetic energy inputs. It is also evident that focal farmers had reduced the cost of producing per quintal wheat from US$ 138.04 to US$ 117.00, i.e., by US$ 21.04 after adopting conservation agriculture practice whereas the cost in case of control farmers was decreased by only US$ 7.79. Return per quintal wheat was increased by US$ 35.37 (i.e., from US$ 159.96 to US$ 195.33) in terms of focal farmers and in terms of control farmers, it was increased by US$ 11.01 (i.e., from US$ 150.38 to US$ 161.38) after practicing conservation agriculture which clearly implies that profit of focal and control farmers per quintal wheat was increased by US$ 56.41 and US$ 26.85, respectively during the research period (Table 3).

Table 3
Profitability per unit final product of wheat crop.
Source: Authors' estimation based on field survey, 2015–16.

Particulars		Farmers' categories					
		Focal			Control		
		Before	After	Difference	Before	After	Difference
i.	Total output (quintal)	0.25	0.24	−0.01	0.24	0.26	0.02
ii.	Total cost (US $)	34.51	28.08	−6.44	34.16	34.98	0.81
iii.	Net return (US $)	39.99	46.88	6.89	36.09	41.96	5.88
iv.	Cost per quintal (US$) (ii ÷ i)	138.04	117.00	−21.04	142.33	134.54	−7.79
v.	Return per quintal (US$) (iii ÷ i)	159.96	195.33	35.37	150.38	161.38	11.01
vi.	Profit per quintal (US$) (v − iv)	21.92	78.33	56.41	8.04	26.85	18.80

Table 4
Profitability per unit final product of bean crop.
Source: Authors' estimation based on field survey, 2015–16.

Particulars		Farmers' categories					
		Focal			Control		
		Before	After	Difference	Before	After	Difference
i.	Total output (quintal)	1.27	1.32	0.05	1.29	1.30	0.01
ii.	Total cost (US $)	94.65	88.38	−6.28	92.66	93.85	1.19
iii.	Net return (US $)	123.34	156.35	33.01	127.65	147.80	20.15
iv.	Cost per quintal (US$) (ii ÷ i)	74.53	66.95	−7.58	71.83	72.19	0.36
v.	Return per quintal (US$) (iii ÷ i)	97.12	118.45	21.33	98.95	113.69	14.74
vi.	Profit per quintal (US$) (v − iv)	22.59	51.50	28.91	27.12	41.50	14.38

The cost of producing one quintal bean and return from one quintal bean is shown in Table 4. It is seen that total output of bean was increased by 0.05 quintal in case of focal farmers and 0.01 quintal in case of control farmers after adopting conservation agriculture. It is also found that focal farmers had reduced the cost of producing per quintal bean from US$ 74.53 to US$ 66.95, i.e., by US$ 7.58 after adopting conservation agriculture practice whereas the cost in case of control farmers was increased from US$ 71.83 to US$ 72.19, i.e., by US$ 0.36. Return per quintal bean was increased by US$ 21.33 (i.e., from US$ 97.12 to US$ 118.45) in terms of focal farmers and by US$ 14.74 (i.e., from US$ 98.95 to US$ 113.69) in terms of control farmers after practicing conservation agriculture which clearly implies that profit of focal and control farmers per quintal bean was increased by US$ 28.91 and US$ 14.38, respectively (Table 4).

3.3. Problem confrontation index (PCI)

The computed PCI score of the 13 problems ranged from 41 to 53 (against a possible range from 0 to 60) for focal farmers and 204 to 258 (against a possible range from 0 to 300) for control farmers which were arranged in rank order according to their PCI scores as shown in Table 5.

Table 5
Problem confrontation index (PCI) including thirteen (13) selected problems.
Source: Authors' estimation, 2015–16.

Identified problems	Farmers' categories											
	Focal (N = 20)						Control (N = 100)					
	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	PCI	Rank order	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	PCI	Rank order
Lack of good quality inputs	11	2	4	3	41	13	65	18	7	10	238	10
High price of inputs	13	4	1	2	48	6	71	20	4	5	257	3
Lack of transportation and storage facilities	12	3	4	1	46	8	59	17	20	4	231	11
Lack of knowledge on conservation agriculture practice	11	3	3	3	42	12	72	10	9	9	245	6
Less production due to minimum tillage	16	2	1	1	53	1	72	12	6	10	246	5
Weed infestation due to minimum tillage	13	1	4	2	45	9	69	11	13	7	242	7
Outbreak of diseases	10	5	4	1	44	10	53	16	16	15	207	12
Crop residues cannot be used as fuel	12	1	5	2	43	11	57	11	11	21	204	13
Crop residues cannot be used as animal feed	13	3	2	2	47	7	69	12	9	10	240	8
Crop rotation being a boring practice	13	4	2	1	49	5	66	10	21	3	239	9
Lack of extension service	15	2	2	1	51	3	70	19	10	1	258	2
Maintenance is difficult	15	3	1	1	52	2	71	20	8	1	261	1
Insufficient institutional credit	13	5	1	1	50	4	68	21	2	9	248	4

3.4. SWOT analysis

SWOT analysis (strengths, weaknesses, opportunities and threats analysis) of conservation agriculture is a framework for identifying and analyzing the internal and external factors that can have an impact on the viability of adopting conservation agriculture.

After adopting this farming system, 56.5% farmers had knowledge about soil conservation. According to 26.4% farmers' testimonies, the use of crop rotation technique had brought some benefits to crop production such as better quality and higher amount of output. 48.3% farmers stated that organic fertilizer provided with better yields and better quality of crops (Table 6).

According to 74.1% farmers, the requirement of labour and synthetic fertilizers was lower in this farming system. 66.9% farmers ensured about better livelihood condition. 37.1% farmers retained crop residue because it was easier than to carry the crop residue to the household. 47.4% farmers reported about lack of sufficient training and motivational programmes (Table 6).

22.0% farmers stated about increased labour opportunities through conservation agricultural practice. 16.8% farmers stated that savings and credit co-operatives were important assets for them. According to 36.4% farmers, the co-operative groups needed a certain amount of initial fee as collateral in order to be a member where other members stated that even though they had to pay, there was a risk they would not get any income. 30.8% farmers could have access to what they needed for a successful planting and harvesting, especially to perform these activities on time. 29.7% farmers showed their excitement and welcomed the demonstrators for teaching them new agricultural methods (Table 6).

44.2% farmers stated that they did not know when the first rainfall would come and so, they could not get ready for the preparation of land. According to 51.6% farmers, sometimes the price of product was low but they had to sell their production even though the price would not cover their production cost (Table 6).

Table 6
SWOT analysis matrix on conservation agriculture practice.
Source: Field survey, 2015–16.

	Positive		Negative	
	Issues	% of farmers	Issues	% of farmers
Internal	**Strengths**		**Weakness**	
	Knowledge on soil conservation and soil quality improvement	56.5	Management of crop residue	37.1
	Practicing crop rotation	26.4	Lack of external help and monitoring	47.4
	Use of organic fertilizer	48.3	Scarcity of cowdung	77.5
	Increase in income for farmers	74.1	–	
	Livelihood improvement opportunities	66.9		
External	**Opportunities**		**Threats**	
	Labour opportunities	22.0	Climate change	44.2
	Savings and credit co-operative organizations	16.8	Price fluctuation	51.6
	Market demand and opportunities	36.4	–	
	Subsidy on agricultural inputs	30.8		
	External training	29.7		

Table 7
Recommendation matrix indicating issues that needed further research, extension and policy recommendation.

Facts of consideration	Recommendations		
	Research needed	Extension needed	Policy intervention needed
Nourishment of farmers' knowledge about conservation agriculture practice		√	
Involvement of government and non-government organizations to provide basic acquaintance to the farmers		√	
Arrangement of training programs by different local, national and international institutions		√	
Regular extension contact from the view point of extension agents		√	√
Ensuring the availability of agricultural inputs at the time of requirement			√
Enhancing direct input support as well as input subsidy programmes for the betterment of the farmers			√
Providing farmers' access to modern agricultural equipments and machineries to facilitate the practice of conservation agriculture	√	√	
Inspiring the farmers to use organic fertilizers instead of synthetic fertilizers	√	√	
Creation of market with comparative advantage of medicine free and organic products	√		
Restricting the use of synthetic fertilizers, pesticides and medicine in crop farming to a minimum limit with a view to protect the environment from being damaged	√		√
Accessibility of the farmers to institutional credit			√
Formation of savings and credit cooperative groups which can ensure the sale of the products of the member farmers			√

3.5. Recommendation matrix

Keeping different internal and external factors in contrast, a set of policy actions is suggested by the researcher for the development of practicing conservation agriculture in the context of Bangladesh which is presented in the form of recommendation matrix (Table 7).

4. Discussion

4.1. Diffusion of innovation and adoption

Diffusion of innovations seeks to explain how, why and at what rate new ideas and technologies spread through cultures. Diffusion is the process by which an innovation is communicated through certain channels over a period of time among the members of a social system. An innovation is an idea, practice or object that is perceived to be new by an individual or other unit of adoption. Communication is a process in which participants create and share information with one another to reach a mutual understanding (Rogers, 1995). The innovation-decision process regarding adoption of conservation agriculture was consisted of five stages: i) knowledge, ii) persuasion, iii) decision, iv) implementation, and v) confirmation.

A farmer was first exposed to the innovation with lack of information about the innovation. During knowledge stage, the farmer had not been inspired to find out more information about the innovation. The farmer was interested in the innovation and actively searched related information/details in persuasion stage. In the stage of decision, the farmer took the concept of the change, weighed the advantages/disadvantages of using the innovation and decided whether to adopt or reject the innovation. The farmer employed the innovation to a varying degree depending on the situation. During implementation stage, the farmer also determined the usefulness of the innovation and searched for further information about it. The farmer finalized the decision to continue using the innovation in confirmation stage which was the authentication of making the right decision.

Rogers (1995) defined an adopter category as a classification of individuals within a social system on the basis of innovativeness and suggested a total of five categories of adopters in order to standardize the usage of adopter categories in diffusion research. The categories of adopters were: innovators, early adopters, early majority, late majority and laggards.

Innovators are farmers who are willing to take risks, have the highest social status, have financial liquidity, are social, and have the closest contact to scientific sources and interaction with other farmers. Their risk tolerance allows them to adopt conservation agriculture that may fail ultimately. Early adopters have the highest degree of opinion leadership among the adopter categories; and have a higher social status, financial liquidity, advanced education and are more socially forward than late adopters. Early majority adopt the innovation after a varying degree of time that is significantly longer than the innovators and early adopters. They have above average social status, contact with early adopters and seldom held positions of opinion leadership in a system. Late majority adopt the innovation after the average participant. They approach the innovation with a high degree of scepticism and after the majority of society have adopted the innovation. Farmers in laggards category show little to no opinion leadership. These individuals typically have a tendency to be focused on traditions, lowest social status, lowest financial liquidity, oldest among adopters, and in contact with only family and close friends. Though majority of the farmers were sceptical about this farming practice at the beginning, the adoption of this practice was ultimately successful.

4.2. Profitability of crop production

A limited amount of input support (i.e., seeds/planting materials, manures and fertilizers, organic pesticides, care and management, etc.) was provided to the focal farmers at free of cost for 10.0 decimal land (command area) for cultivating crops following the principles of conservation agriculture. Control farmers did not receive any kind of input support or technical advice for practicing such farming and they produced crop following conventional crop farming.

Synthetic fertilizers and medicine free products that were supplied by focal farmers in the market, gained higher consumer attraction compared to those of the products supplied by control farmers which made a comparative advantage for focal farmers to sell the product at higher price in the market. The results are faintly similar with Uddin et al. (2016) where the authors found that focal farmers were more profitable in crop farming compared to proximal and control farmers.

4.3. Problems regarding conservation agriculture practice

The farmers of the study areas were asked to give their opinion on 13 selected problems which were identified during data collection period and after computing the PCI scores, the problems were ranked according to their PCI score.

4.3.1. Lack of good quality inputs

Lack of good quality inputs was one of the major problems faced by the farmers in the research areas. Precisely, availability of good quality seeds and fertilizers was infrequent to the farmers. According to the perceptions of the farmers, the PCI score of this problem stood 41 and 238 in case of focal and control farmers, respectively which resulted in

a rank of this problem as 13th and 10th, accordingly.

4.3.2. High price of inputs

Majority of the farmers opined that the prices of the production inputs were very much higher for them to meet the production expense. The PCI score of this problem was 48 and 257 ranking by 6th and 3rd in terms of focal and control farmers, respectively.

4.3.3. Lack of transportation and storage facilities

Transportation of products was not easy for the farmers in the research areas because of underdeveloped road communication system. A vast amount of products were being damaged because of this reason. Also, storage facility was weak and as a result, storing of products for future sale was reasonably uncertain. This problem was ranked as 8th and 11th with PCI score of 46 and 231 according to focal and control farmers, respectively.

4.3.4. Lack of knowledge on conservation agriculture practice

Being a new dimension of crop farming, the practice of conservation agriculture was up-to-the-minute to the farmers. The knowledge of the farmers on this aspect was not immensely transparent. Lack of appropriate knowledge on this farming practice was a great knotty issue for the farmers. As stated by focal and control farmers, this problem was ranked as 12th and 6th by means of PCI score of 42 and 245, respectively.

4.3.5. Less production due to minimum tillage

Soil tillage requirement for crop farming in Bangladesh does not permit minimum tillage in case of most of the crops which forestalls maximum crop production. The farmers of the research areas stated this as one of the major problems. The problem was ranked as 1st and 5th in accordance with the PCI score of 53 and 246 with the opinion of focal and control farmers, respectively.

4.3.6. Weed infestation due to minimum tillage

Another problem identified by the farmers was weed infestation because of less tillage than requirement. The PCI score of this problem was calculated at 45 and 242, which was ranked as 9th and 7th along with the statements of focal and control farmers, respectively.

4.3.7. Outbreak of diseases

It was experienced by the farmers that the crop plants were affected by different kinds of diseases attributable to fungus and pests which hindered their crop production. The problem was severely faced by focal farmers who did not use any kind of synthetic pesticide or medicine. With the statements of focal and control farmers, the PCI score of this problem was determined as 44 and 207 which was ranked as 10th and 12th, respectively.

4.3.8. Crop residues cannot be used as fuel

The farmers of the research areas stated that the crop residue they left on the crop field could be effectively used as fuel. According to the perceptions of the farmers, the PCI score of this problem stood 43 and 204 in case of focal and control farmers, respectively which resulted in a rank of this problem as 11th and 13th, accordingly.

4.3.9. Crop residues cannot be used as animal feed

Same as before, the crop residue could be used for feeding the livestock, opined by the farmers. This problem was ranked as 7th and 8th with PCI score of 47 and 240 according to focal and control farmers, respectively.

4.3.10. Crop rotation being a boring practice

Most of the farmers stated the selection of an appropriate crop rotation as a boring practice. With the statements of focal and control farmers, the PCI score of this problem was dogged as 49 and 239 which was ranked as 5th and 9th, respectively.

4.3.11. Lack of extension service

A noticeable number of farmers in the research areas stated that they experienced lack of extension contact. The frequency of visit by the extension agents in the research areas was very limited. The problem was ranked as 3rd and 2nd as per the PCI score of 51 and 258 according to focal and control farmers, respectively.

4.3.12. Maintenance is difficult

The maintenance of conservation agriculture practice was seemed to be difficult than conventional farming practice to some of the farmers. As stated by focal and control farmers, this problem was ranked as 2nd and 1st by means of PCI score of 52 and 261, respectively.

4.3.13. Insufficient institutional credit

Inadequate credit facility was another major problem faced by the farmers in the research areas. The credit lending process of different formal credit lending institutions was not transparent to them and as a result, they had to depend on different informal sources of credit like moneylenders, relatives, friends, etc. The PCI score of this problem was calculated at 50 and 248, which was ranked as 4th problem along with the statements of both categories of farmers (focal and control farmers).

The results are supported by Uddin et al. (2017) where the authors found high price of inputs, lack of institutional credit, lack of knowledge about conservation agriculture, etc. as the major problems faced by the farmers in the study areas.

4.4. Prospects of practicing conservation agriculture

The main strengths found in conservation agriculture practice are described and listed in the following section to provide an overview of the positive and outstanding factors contributing to a more efficient use of resources and better outcomes for farmers.

4.4.1. Knowledge on soil conservation and soil quality improvement

Farmers not only knew some of the consequences of a bad soil management but also the benefits of conserving it. Major problems according to the farmers were: lack of nutrients, lower yields and bad quality of crops. That knowledge favoured farmers and contributed positively to their farming practices. Farmers had implemented techniques and methods, such as contours and ridges to prevent rainfall to wash away fertilizers and seeds. They had also implemented other techniques to conserve the soil such as crop rotation and less use of chemical fertilizers. The positive and negative results due to the good or bad soil management had been an experience for the farmers. In addition to better and higher yields, farmers had noticed that land preparation became less hard which helped them to save effort and time.

4.4.2. Practicing crop rotation

Farmers stated that previously they did not use this technique, but they got some training from local NGOs where there were taught about benefits of crop rotation and which type of crops to plant. After this training, they had also noticed that amount of weeds had decreased, and soil could recover from previous seasons and get more nutrients.

4.4.3. Use of organic fertilizer

Before adopting conservation agriculture, farmers used to apply only synthetic fertilizers because they did not know about different benefits and the proper way to apply organic fertilizers. After adopting this farming practice, they used both synthetic and organic fertilizers, and after the successful results from using organic fertilizers, they stated that they would like to shift to use only organic fertilizers. The shift to organic fertilizers from synthetic fertilizers had almost doubled the production for some farmers. They had also experienced a big difference when preparing the soil for the next season. The soil became

more workable and the amount of weed was low. According to the farmers, when using synthetic fertilizers, the nutrients and minerals from the soil were less which could be one of the causes for lower yields.

However, the demand for organic fertilizers was increasing and sometimes it was not enough to cover all the cultivating plots, therefore, they had to complement with synthetic fertilizers. Farmers became aware of the benefits of using organic fertilizers and consequences of using synthetic fertilizers. They had been looking for alternatives to reduce the amount of using synthetic fertilizers and to find solutions for the availability of organic fertilizers.

4.4.4. Increase in income for farmers

The farmers were positively influenced by the quality and quantity of the production. They could sell their products to a higher price and meet their needs. Farmers could save a remarkable amount of money and, therefore, invest that money in other income generating activities. As time was also saved in this practice, farmers could engage themselves with other non-farming activities and earn a lucrative amount of money income. Increase in income also helped the farmers to invest in other sectors of agriculture like livestock, fishery and agroforestry.

4.4.5. Livelihood improvement opportunities

The livelihood condition of the farmers began to improve because of their higher income. They were able to have better houses and improve livestock sheds. They had ensured access to clean and pure drinking water. The rate of child mortality and child undernourishment had been decreased. Farmers could send their children to school and ensure mandatory primary education. Availability of electricity among the farmers was also increased.

The following weaknesses were considered as constraints affecting conservation agricultural practices that causing a negative impact on the farmers and their products.

4.4.6. Management of crop residue

Management of crop residue required additional and improved knowledge about other uses of crop residue besides using them for livestock feeding which was lacking among the farmers. Farmers in the research areas mainly collected crop residue for livestock feeding purposes. The residues from long distance lands were burned at the field. Majority of the farmers knew about consequences of burning crop residue to the soil. To carry them, they needed additional transportation, which implied additional workload as well as the use of valuable time during the day. A few farmers commented that agricultural officers together with local NGOs provided with some demonstrations about the use of crop residue but that was not adequate. Therefore, farmers did not have the opportunity to put in practice what they learnt and they could not see any benefit for it. Farmers preferred others to try first and prove that it worked before deciding to try themselves.

4.4.7. Lack of external help and monitoring

One of the major constraints found in the research areas was the lack of monitoring and supervision by the agricultural extension officers. According to the agricultural extension officers, the transportation system was not enough suitable to visit the areas to provide effective supervision and monitoring. Besides, there was shortage of extension staff to take care of this supervision. To improve the practice of conservation agriculture, farmers asked for more seminars and demonstration by GOs and NGOs. Farmers stated that usually when there were training seminars, only a few of them were invited or included. Farmers who usually participated, sometimes they did not share what they learnt. Therefore, they did not get new information. Farmers attributed this to the lack of organization.

4.4.8. Scarcity of cowdung

Most of the farmers applied cowdung as organic fertilizer to their crops. The result of applying cowdung was positive. However, a noticeable amount of farmers still used chemical fertilizers because of scarcity of cowdung. In the research areas, a small number of farmers had cows and so, the supply of adequate amount of cowdung was not possible. 77.5% farmers revealed that their only and easier option was to continue using chemical fertilizer though they knew about its consequences and low yields.

Opportunities are external factors that are beneficial for the farmers which can contribute to the improvement and success of conservation agricultural practice.

4.4.9. Labour opportunities

Labour opportunities aroused since the required labour for agricultural activities decreased due to implementation of conservation agricultural. Therefore, farmers and other family members had the opportunity of working either in other lands or find other sources of employment in the local town or nearby. Farmers had the option of using bioslurry and IPM technology as an alternative to reduce workload in weed and pest management. A few farmers had already used these technologies and they expressed that it reduced workload in fact, but it required additional knowledge on the correct doses, appropriate product, required equipment and timely use of it in order to be succeeded in this method.

4.4.10. Savings and credit co-operative organizations

A number of NGOs in the research areas provided farmers with credit to buy their inputs and they provided the savings service which was a good opportunity for the farmers to save their profit and to have it available for the next season. These NGOs also provided facilities on payments so that farmers could borrow money to buy their inputs on time and a certain amount every month. Having access to credit facilitated this farming practice for the farmers.

4.4.11. Market demand and opportunities

Market can be seen as a great opportunity to guarantee the sale of the products of the farmers. The demand for organic agricultural products was higher in local, national as well as in the international market. The price was also higher because of the scarcity of organic products. Other marketing opportunity was through the co-operative groups. These co-operative groups bought all the production from the farmers who were members and they were in charge of selling them in the local market or to private buyers. The advantage was that members became sure to sell all their production.

4.4.12. Subsidy on agricultural inputs

In order to support the farmers and help them with some of the input expenses, the government had assigned subsidy programmes to cover some of these. The demand of inputs was high at the start of cropping season. Extension officers had the opportunity to make it sure that the inputs needed were available at that time. Even though this subsidy did not cover all the inputs for every season, farmers stated that it was a small but significant support and they could save some money.

4.4.13. External training

External help from different GOs and NGOs was one of the most important opportunities for the farmers in the research areas. Local NGOs provided with practical demonstrations to the farmers to show the management of crop residue, maintenance of crop rotation and the use of organic fertilizers. They also provided special training and constant assessment, and worked directly in the land of the selected farmers to make them realize the results. Afterwards they could choose whether to adopt or not. These training programmes created a positive impact in adoption of conservation agriculture. Farmers, who had been part in training programmes before, were more likely to adopt new agricultural practices. Since the farmers had participated in these organizations, the opportunities to expand and introduce new practices

were feasible.

Threats are external factors that can adversely affect the performance or achievement of the goals of conservation agricultural practice.

4.4.14. Climate change

Sometimes the rainy season started after a long time of the expected period. Not only late rainfall but also the rainy season stopped before anticipated. Although it rained, the farmers did not know whether it would actually be enough to have a good harvest. Sometimes they had experienced consequences of unexpected extreme rainfall.

4.4.15. Price fluctuation

Market is considered as an important opportunity for the farmers to sell their production. However, price is a threat for the farmers. For the majority of the farmers, selling products did not represent any profit. The lack of intervention from the government and the lack of organization among the farmers were considered as the core causes for that instability. According to the farmers, even though they had complaint about that to the extension officer, the issue had never been solved.

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